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NUTRIENT DIGESTIBILITY DETERMINATION OF *CASSAVA*, *LEUCAENA*, *STYLOSANTHES*, *MORINGA* AND *TRICHANTHERA* LEAF MEALS IN CHICKENS

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Abstract

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The aim of this study is to determine the nutrient digestibility of *cassava* leaf meal (CLM), *Leucaena leucocephala* leaf meal (LLM), *Stylosanthes guianensis* grass meal (SGM) *Moringa oleifera* leaf meal (M.LM) and *Trichanthera gigantea* leaf meal (T.LM) in Luong Phuong broiler chickens. The study was carried out based on the nutrient digestibility of 2 diets: 1) The basal diet without the inclusion of leaf meals and 2) the experimental diet consisting of 80% basal diet and 20% leaf meals. Based on the nutrient digestibility and the total digestible matter of the 2 diets, the nutrient digestibility of leaf meals was calculated. The results showed that crude protein, lipid, fiber, non – nitrogen extract digestibility of CLM was 63.35; 75.91; 22.02 and 68.30%, respectively. That of LLM was 68.27; 79.76; 24.67 and 70.89%, respectively. That of SGM was 65.18; 69.23; 18.89 and 67.58%, respectively. That of MLM was 67.97; 78.15; 25.48 and 72.84 %, respectively. And that of TLM was 65.43; 72.73; 23.08 and 68.90%, respectively. The formulation of a diet based on the nutrient digestibility of the feed ingredients was recommended in order to obtain optimum performance of broiler chickens.

Key word: leaf meals; nutrients; digestibility
Abbreviations: AIA (Acid – Insoluble Ash); BD (Basal diet); ED_1, ED_2, ED_3, ED_4 and ED_5 (Experimetal diet 1, 2, 3, 4 and 5); LM (Leaf meal); CLM (Cassava leaf meal); LLM (*Leucaena leucocephala* leaf meal); SGM (*Stylosanthes guianensis* grass meal); MLM (*Moringa ooleifera* leaf meal); TLM (*Trichanthera gigantea* leaf meal)

Introduction

A large amount of leaves can be harvested from *cassava, Leucaena*, *Moringa*, *Trichanthera* and *Stylosanthes* forage crops. The total leaf meal (ton/ha/year) yield from *cassava* was 4.69 – 7.76 tons (Hoan, 2012; Hien and Trung, 2016), from *leucaena* was 6.69 - 9.83 tons (Hoan et al, 2017; Hien et al., 2008) and from *stylo* was 6.05 tons (Ngoc, 2012). Recently, these leaf meals have been extensively used as feed supplements in poultry diets in order to improve productivity as well as product quality. Thanks to pigment content in these leaf meals, it proved that this content increased chicken's skin yellow darkness, improved egg yolk color, and increased meat and egg palatability (Sirri et al., 2007; Lascha, 1990; Williams, 1992; Hien et al, 2016).

However, in Vietnam, there was very little known about the nutrients digestibility of these leaf meals in chickens Thus, this study was conducted in order to provide more scientific evidence of using CLM, LLM, SGM, MLM and TLM to be included into broiler's diet.

Materials and Methods

The Luong Phuong broiler breed was used in this experiment from 43 – 50 days of age with a total of 180 birds divid-

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ed into 6 groups, with each group consisting of 5 subgroups of 6 birds each (3 male and 3 female).

The leaf of cassava (*Manihot esculenta crants*), *leucaena leucocephala*, *stylosanthes guianensis*, *Moringa oleifera and Trichanthera gigantea* forage crops was used for this trial. The leaves were sun dried and ground. The ground leaves were screened with 1mm screen mesh prior mixing into basal diet.

Six different diets were prepared for the 6 groups including basal diet (BD) without inclusion of leaf meals, experimental diet 1 (ED1) consisting of 80% basal diet plus 20% CLM, experimental diet 2 (ED2) consisting of 80% basal diet plus 20% LLM, experimental diet 3 (ED3) consisting of 80% basal diet plus 20% SGM. Experiment diet 4 (ED_4) consisting of 80% basal diet plus 20% MLM and Experiment diet 5 (ED_5) consisting of 80% basal diet plus 20% TLM. The exact amount of 1.5% acid insoluble mineral (Cr_2O_3) was added into each diet.

The basal diet was prepared from ground corn, wheat bran, soybean meal, fish meal, premix minerals and vitamins. The metabolic energy (ME) and crude protein (CP) contents of the basal diet was in compliance with standard nutrient requirements of the colored feather broiler from 43 days old to slaughter age.

The feed ingredients, leaf meal and diets were chemically analyzed before the experiment was conducted. The chemical compositions of leaf meals, basal and experiment diets are presented in Table 1.

The trial was conducted in the chicken farm of Thai Nguyen University of agriculture and forestry. The experiment was performed in 7 days. The first 4 days, the birds were given time to adapt to the cage and diets. At 4:00 p.m. on day 4, birds were restricted from feed, at 8:00 a.m. of day 5, the experimental diets were given to birds, at 4:00 p.m. on day7, the birds were restricted from feeds, and at 8:00 a.m. of the day 8, the birds were dissected to collect the ileal contents.

Ileal content collection was performed following the method of Bryden et al., 2009; Jamroz et al., 2001; Kadim and Moughan, 2008 The ileal contents were dried at low temperature prior to chemical analysis..

The chemical analysis was done following A.O.A.C., 1990. Acid insoluble ash analysis was performed after Keulen and Young (1977). Each index was analyzed with 5 repetitions

Nutrients digestibility was calculated after Tu Quang Hien et al., 2013.

Digestibility (%) = 100 – 100 x c/a x b/d

Whereas: a - nutrient content in diet (% DM), b - nutrient content in ileal contents (% DM), c - insoluble mineral in feed (%DM) and d - insoluble mineral in ileal content (% DM).

Results and Discussions

- ***The chemical composition of diets and ileal contents***

The chemical composition of the diets and the ileal contents including crude protein, lipid, fiber, acid insoluble ash was analyzed. The results were presented in Table 2 and Table 3.

Table 2
Chemical composition of diets (% DM)

Diets	CP	EE	CF	NFE	AIA
BD	20.14	3.85	4.17	58.60	2.149
ED_1	20.63	4.59	6.41	55.57	2.130
ED_2	21.56	4.00	5.00	56.66	2.108
ED_3	19.56	3.50	9.67	54.50	2.098
ED_4	23.71	4.38	5.06	54.00	2.135
ED_5	21.52	3.81	5.37	54.75	2.176

Table 1
Chemical composition of leaf meals, basal and experiment diets (%)

LM and BD	DM	CP	EE	CF	Ash	NFE[3]
Cassava (CLM)	90.39	20.73	6.93	13.97	8.68	40.08
L. leucocephala (LLM)	90.53	24.98	4.22	7.56	8.63	45.14
S. guianensis (SGM)	90.61	15.97	1.98	28.65	8.59	35.42
M. oleifera (MLM)	90.49	34.68	5.93	7.85	8.86	33.17
T. gigantea (TLM)	90.56	24.78	3.37	9.23	16.64	36.54
Basal diet (BD)[1]	88.45	18.12	3.46	3.76	10.38	52.73
Basal diet (BD)[2]	88.63	17.85	3.41	3.70	11.73	51.94
ED1[2]	89.01	18.36	4.09	5.71	11.39	49.46
ED2[2]	89.03	19.20	3.56	4.45	11.38	50.44
ED3[2]	89.05	17.42	3.12	8.61	11.37	48.53
ED4[2]	89.03	21.11	3.90	4.51	11.43	48.08
ED5[2]	89.04	19.16	3.39	4.78	12.96	48.75

Note: (1) before AIA addition, (2) after AIA addition. (3) NFE = DM – (CP+EE+CF+Ash)

Table 3
Chemical composition of ileal contents (%DM)

Diets	CP	EE	CF	NFE	AIA
BD	17.84	2.27	8.92	45.54	6.094
ED_1	17.90	2.66	13.11	42.22	5.670
ED_2	18.67	2.27	10.38	43.87	5.816
ED_3	16.15	1.99	19.70	40.31	5.404
ED_4	20.13	2.46	10.24	39.59	5.743
ED_5	19.42	2.37	11.48	42.98	6.105

Based on the chemical composition and acid insoluble ash contents of the diets and the ileal contents presented in Table 2 and Table 3, the digestibility of diet's nutrients were calculated.

● ***The nutrients digestibility of experimental diets***

There were 3 steps in order to determine the nutrient digestibility of the experimental diets, including *i)* Determination of acid insoluble ash / nutrients ratio (c/a) of the diets, *ii)* Determination of nutrients / acid insoluble ash ratio (b/d) of the ileal contents, and *iii)* Based on the formula described in the materials and methods section to calculate the nutrient digestibility.

Based on the acid insoluble ash content (c) and nutrients content in the diets (a) presented in Table 2, the ratio (c/a) was calculated and is presented in Table 4.

Table 4
The Acid insoluble ash (AIA) and nutrients content ratio

Diets	CP	EE	CF	NFE
BD	0.107	0.558	0.515	0.037
ED_1	0.103	0.464	0.332	0.038
ED_2	0.098	0.527	0.422	0.037
ED_3	0.107	0.599	0.217	0.038
ED_4	0.090	0.487	0.422	0.040
ED_5	0.101	0.571	0.405	0.040

Based on the nutrient content (b) and acid insoluble ash (d) in ileal contents presented in Table 3, the (b/d) ratio was calculated and is presented in Table 5.

Table 5
The nutrients content and acid insoluble ash ratio of ileal contents

Diets	CP	EE	CF	NFE
BD	2.927	0.372	1.464	7.473
ED_1	3.157	0.469	2.312	7.446
ED_2	3.210	0.390	1.785	7.543
ED_3	2.989	0.368	3.645	7.459
ED_4	3.505	0.428	1.783	6.894
ED_5	3.181	0.388	1.880	7.040

Based on the c/a ratio in the diets and the b/d ratio in the ileal contents, the nutrient digestibility of the experimental diets was calculated by using the formula described in the Materials and Methods section. The results are shown in Table 6.

Table 6
Nutrient digestibility of experimental diets (%)

Diets	CP	EE	CF	NFE
BD	68.68	79.24	24.60	72.35
ED_1	67.48	78.24	23.24	71.71
ED_2	68.54	79.45	24.67	72.09
ED_3	68.02	77.96	20.90	71.66
ED_4	68.46	79.16	24.76	72.42
ED_5	67.87	77.85	23.86	71.84

Based on data presented in Table 6, it can be predicted that the digestibility of protein from LLM, SGM, MLM was higher than that from CLM, TLM, and the digestibility of lipid from CLM, LLM, MLM was higher than that from SGM, TLM whereas, fiber digestibility of SGM was lower than that of CLM, LLM, MLM and TLM.

● ***Nutrients digestibility of leaf meals***

In order to determine the nutrients digestibility of leaf meals, 3 steps had to be done, *i)* Determination of total leaf meals nutrients intake, *ii)* Determination of total digested leaf meals nutrients, and *iii)* Digestibility of leaf meals nutrients.

Step 1: Total leaf meals nutrient intake

Total leaf meal nutrient intake (here after named as C) was calculated based on the nutrient intake from the experimental diets (ED) here after named as A, minus the nutrient content in basal diet (BD in ED) here after named as B. The total leaf meals nutrient intake was C = A – B. The calculation results are presented in Table 7.

Data presented in Table 7 showed that the crude protein intakes of MLM was the highest, followed by LLM, TLM, CLM and SGM, that of lipid was ranked in order from highest to lowest as CLM, MLM, LLM TLM and then SGM, and that of fiber was ranked from highest to lowest as SGM, CLM, TLM, MLM and then LLM. Thus, when total feed intake was similar amongst the treatments, the total nutrient intake depended on the nutrient content in the leaf meal

Step 2: The total digested nutrients of leaf meals

The amount of digested nutrient content in leaf meals, here after named as D, was calculated based on the digested nutrients in the experimental diets (ED) here after named as

Table 7
Total nutrients intake of experimental diets and leaf meals (g/bird/day)

Diets and leaf meals		CP	EE	CF	NFE
ED_1	A	18.51	4.12	5.76	49.86
BD in ED_1	B	14.39	2.75	2.99	41.88
CLM	C	4.12	1,37	2.77	7.98
ED_2	A	19.43	3.60	4.50	51.05
BD in ED_2	B	14.45	2.76	3.00	42.05
SGM	C	4.98	0.84	1.50	9.00
ED_3	A	17.32	3.10	8.56	48.24
BD in ED_3	B	14.19	2.71	2.95	41.30
SGM	C	3.13	0.39	5.61	6.94
ED_4	A	21.32	3.94	4.56	48.56
BD in ED_4	B	14.42	2.75	2.99	41.97
MLM	C	6.90	1.19	1.57	6.59
ED_5	A	19.10	3.38	4.77	48.60
BD in ED_5	B	14.24	2.72	2.95	41.43
TLM	C	4.86	0.66	1.82	7.17

Note: Feed intake of BD, ED_1, ED_2, ED_3, ED_4, ED_5 was 100.6; 100.8; 101.2; 99.4; 101.0 and 99.7 g/bird/day respectively. After AIA addition, the proportion of BD in ED was 78.8 %

E, minus the nutrient content in the basal diet (BD in ED) here after named as H. Thus, D = E – H. The calculation results are presented in Table 8.

The total digested nutrients were dependent on *i)* total leaf meals nutrient intake and *ii)* the digestibility of that nutrient. Data presented in Table 7 and Table 8 showed that the crude protein intakes of MLM were the highest, so that their digestibility was also the highest. Similarly, the lipid intake of CLM was the highest so that its digestibility was also the highest. The same findings were also observed for fiber digestibility of SGM. It can be concluded that the difference in the nutrient digestibility of the different kind of leaf meals was not significant to change this above mentioned order.

Table 8
The total digested nutrients of experimental diets and leaf meals (g/bird/day)

Diets and leaf meals		CP	EE	CF	NFE
ED_1	E	12.49	3.22	1.34	35.75
BD in ED_1	H	9.88	2.18	0.73	30.30
CLM	D	2.61	1.04	0.61	5.45
ED_2	E	13.32	2.86	1.11	36.80
BD in ED_2	H	9.92	2.19	0.74	30.42
LLM	D	3.40	0.67	0.37	6.38
ED_3	E	11.78	2.42	1.79	34.57
BD in ED_3	H	9.74	2.15	0.73	29,88
SGM	D	2.04	0.27	1.06	4.69
ED_4	E	14.59	3.12	1.13	35.17
BD in ED_4	H	9.90	2.19	0.73	30.37
MLM	D	4.69	0.93	0.40	4.80
ED_5	E	12.96	2.63	1.14	34.91
BD in ED_5	H	9.78	2.15	0.72	29.97
TLM	D	3.18	0.48	0.42	4.94

Step 3: The leaf meals nutrient digestibility

The digestibility of protein, lipid, fiber, NFE was estimated based on total digested nutrients (Data presented in Table 8) divided by the total nutrient intake (Data presented in Table 7) multiplied by 100. Results of this calculation are presented in Table 9.

Amongst the 5 tested leaf meals, nutrient digestibility of MLM and LLM was higher than that of CLM, TLM and SGM. This was because the protein content of MLM and LLM was higher than that of 3 rest leaf meals and they also had a lower fiber content compared to other tested leaf meals.

The fiber content of SGM was the highest because SGM was prepared with stem and leaves, thus lignin content in the stem might contribute to the lower fiber digestibility compared to other tested leaf meals.

Table 9
The digestibility of leaf meals nutrients (%)

Leaf meal	CP	EE	CF	NFE
CLM	63.35	75.91	22.02	68.30
LLM	68.27	79.76	24.67	70.89
SGM	65.18	69.23	18.89	67.58
MLM	67.97	78.15	25.48	72.84
TLM	65.43	72.73	23.08	68.90

Conclusion

The protein, lipid, fiber, NFE digestibility of CLM was 63.35; 75.91; 22.02 and 68.30%, respectively, that of LLM was 68.27; 79.76; 24.67 and 70.89%, respectively, that of SGM was 65.18; 69.23; 18.89 and 67.58%, respectively, that of MLM was 67.97; 78.15; 25.48 and 72.84%, respectively and that of TLM was 65.43; 72.73; 23.08 and 68.90%, respectively.

The formulation of a diet based on the nutrient digestibility of the feed ingredients was recommended in order to obtain optimum performance of broiler chickens. In other hand, based on digestibility and content of nutrients in the leaf meal, metabolic energy of leaf meal can be calculated.

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